

DCU-3 Digital Antenna  
Rotator Controller  
With Programmable Memory  
For the  
HAM-IV and T-2X

Model DCU-3 Instruction Manual

***hy-gain.***

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## Precautions

**Towers and antennas require caution during erection and placement! Extreme care must be taken during erection so that metal tower and antenna parts DO NOT contact power lines, even if the parts slip, rotate, retract, fall or fracture!**

**Antenna position mechanisms (towers and rotators) must be placed so that if they fail, the parts of the antenna system cannot contact power lines, be a hazard to individuals, or endanger property.**

The DCU-3 Control Unit is not weatherproof and must be located in a house or other protected location. Connect a ground wire to the 1/4"-20 terminal on the back of the DCU-3.

**Metal towers must be grounded properly at the tower location before the tower is erected. This is to minimize electrical hazard and reduces the possibility of lightning damage. DO NOT bury bare aluminum wires or stakes in the ground. Use copper or copper-clad ground stakes. The service entrance ground should be checked. The household electrical outlet should be the 3-prong type (grounded back to the service entrance). Follow all local building codes and the NFPA National Electric Codes for grounding.**

The DCU-3 has been carefully designed and manufactured to give many years of trouble-free service when carefully and professionally installed. It consists of the strongest and best commercially available components. This product is manufactured in the U.S.A.

## DCU-3 Digital Antenna Rotator Controller

The DCU-3 digital control unit features a Large LCD display indicating the beam heading, manual and computer controlled beam heading selection, manual rotation controls and 6 heading memory storage positions. Settings in memory include brake delay, rotator coast control, North and South center headings, adjustable sleep time, and call sign display.

Your existing rotator unit (HAM IV, T2X, or compatible) must be connected to the control unit with an 8-wire cable. You may use your existing cable, you may assemble your own cable from the information supplied in this manual, or you may purchase pre-assembled.

### DCU-3 Digital Control Unit Specifications:

Size	4.125" x 8.5" x 9"	
Weight	6.25 lbs. (2.84 Kg)	
Voltage	120VAC or 240VAC (optional DCU-3X)	
Brake Delay	0-8 seconds	DEFAULT 3
Coast Delay	0-10 seconds	DEFAULT 0
Sleep Delay	1-240 minutes or continuous ON	DEFAULT 20
Heading Memories	6	

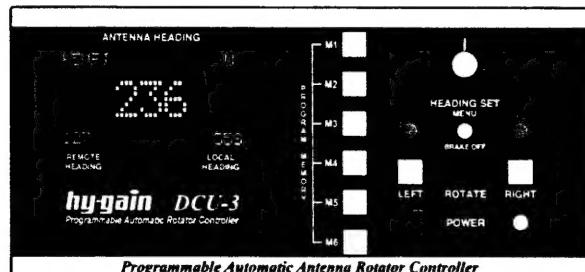


Figure 1 Front Panel

#### Front Panel Controls

POWER	Power ON/OFF
LEFT	Manually rotate left/CCW
RIGHT	Manually rotate right/CW
HEADING SET/MENU	Set the locally controlled antenna heading or bearing. Pushing in the "HEADING SET" selects any menu or the menu function selected or executes the menu function.
ROTATE	Instructs the controller to rotate the antenna to the locally set heading.
M1-M6	Memory storage buttons.

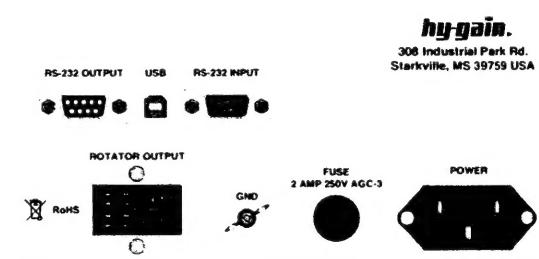


Figure 2 Back Panel

#### Back Panel Connections

RS-232 INPUT	Input COM Port
GROUND	Chassis ground
RS-232 OUTPUT	Output loop through
FUSE	Protective fuse
USB	USB COM Port
ROTATOR OUT	Rotator connections
POWER	120 VAC Input (240VAC Input optional)

# Installation

## Rotator Precautions

1. Unbalanced weight: Weight should be as closely balanced as possible. Unbalanced weight in an antenna creates a bending moment of force which is concentrated on the mast at the point where it is clamped to the rotator.
2. Wind Pressure: Balanced wind pressure against the antenna system produces a bending force on the mast which can cause the same stresses as unbalanced weight. To minimize these forces, a thrust bearing should be used where possible, the antenna should be as close to the top of the tower as possible and the rotator shelf should be as low as possible
3. Unbalanced Wind: If the antenna has unequal wind areas and element spacing on each side of the mast attachment point, it could produce torque on the support mast. This is similar to the principle of a weather vane. If the unbalance is high enough or the wind velocity is high enough, this could prevent rotation or could damage the limit switches. To minimize this effect, the antenna should be designed for minimum mast torque or "torque compensators" added to produce minimum mast torque.
4. Mast Binding: If the antenna support mast binds within the tower due to ice accumulation or other reasons, this could prevent rotation
5. Extreme Cold: If the ambient temperature is at or below -30 degrees F, this could prevent rotation. Older HAM-M, II, III or IV and older T2X units may be sluggish at temperatures less than 0 degrees F.

The DCU-3 checks for rotator movement upon giving the command to rotate and if no movement is detected within 8 seconds, it will stop trying to rotate. If no movement is detected the display will flash MOTOR above the main heading display.

## Wiring and Check-Out

1. Write down the colors of the wires attached to your existing rotator control unit:

### CAUTION:

The new connector is numbered differently than the terminal strip. Pay close attention to the pin numbers! You may wish to check your wiring by measuring the rotator resistances as shown in Table 6 Rotator Resistance Readings.

2. Disconnect the wires from your existing control unit. Attach these to the 8-pin connector to the same numbered pins.
3. If this is a new installation, assemble the rotator cable as shown in Figure 3, or purchase a pre-assembled cable.
4. Temporarily attach the mounting screws to the bottom of the rotor unit. These will be used to support the rotator during bench-testing.

Terminal	Color
1	
2	
3	
4	
5	
6	
7	
8	

Table 1 Wire Color List

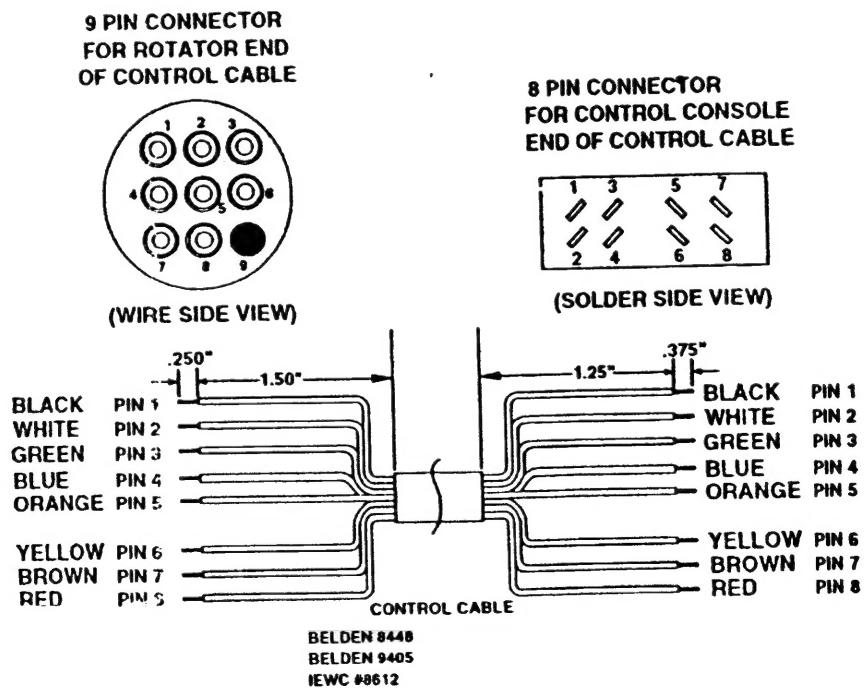


Figure 3 Control Cable Connector Attachment

**CAUTION:**

**Shorts between terminals or grounded leads may damage the rotator. Check the numbered pins on each connector with an Ohmmeter! Pin 1 is connected to pin 1, etc.**

Belden 8448  
Belden 9405  
IEWC #8612

**Table 2 Recommended Cables**

- With the rotator sitting in the upright position (either on the bench or on the tower) and connected to the control unit by the 8-wire cable, plug the control unit power cord into a receptacle and turn it on.
- The DCU-3 display should look similar to the display shown in Figure 4. The numeric display in the center indicates the current bearing of your rotator. The numeric display in the lower right corner indicates the target bearing that is manually set. The numeric display in the lower left indicates target bearing that is computer set. The character display in the upper right corner indicates the compass heading in "NESW" format. The alphanumeric display in the upper left corner is where the call sign is displayed if programmed. If the center display reads a steady "999", disconnect your control cable and check the cable wiring with an ohmmeter. See the section "Checking the Rotator Resistances from the Ground". Proceed if the cable checks OK. 999 also indicates that the cable may not be not plugged in or the right stop has not been set.

**NOTE:**

**The specifications call for heavier gauge wire in two locations. Leads #1 and #2 must be heavier gauge and less total lead resistance**

Maximum Length	Gauge for Terminals 1 & 2	Gauge for Terminals 3-8
125' (38 M)	#18 (1.19 mm)	#20 (0.97 mm)
200' (61 M)	#16 (1.42 mm)	#18 (1.19 mm)
300' (91 M)	#14 (1.75 mm)	#16 (1.42 mm)

**Table 3 Wire Size**

K5MFJ MOTOR NE  
090 CABLE 123  
045

**Figure 4 LCD Display****NOTE:**

**MOTOR is displayed when there is no indication of rotator movement and CABLE also indicates a cable problem.**

- If the current bearing display shows a number between "000" and "359", then proceed. Twist the HEADING SET knob. The LOCAL HEADING display should change. Using the knob, select a target bearing at least 30 degrees from the current bearing. Push the "ROTATE" button. The brake in the rotator should release, the rotator will turn a few degrees in the opposite direction, reverse direction, and then turn to the target bearing. The rotator should turn to the heading plus or minus 2 or 3 degrees. The brake solenoid will "hum" for 3 seconds or what the menu brake setting was set to if changed, then the brake will engage. During rotation the display will show the actual heading

as it turns. If operation does not work as described, immediately unplug the unit from the AC line and check cable wiring!

8. You may wish to repeat step 6 to confirm operation over a wide range of bearings. If the operation is consistent, proceed to the next step.
9. Calibrate the rotation stops of the DCU-3.
  - a. Rotate to the left manually by pressing the LEFT button until the rotator reaches the left mechanical stop then release.
  - b. Press and hold the MENU button until the menu is displayed.
  - c. Turn the Heading Set knob if necessary to select "1.CALIBRATE" then press the Heading set knob in to select the function.
  - d. Turn the knob to select "1. LEFT STOP SOUTH" then press the Heading Set knob in to select. You may see the display change to 181 or 182 and the display will say LEFT STOP.
  - e. Next rotate the rotator to the right mechanical stop using the RIGHT button. The display may display the antenna heading of "999" when initially rotation to the right stop. This is OK as long as the left stop did not also display the antenna heading of "999".
  - f. Press and hold the MENU button until the menu is displayed.
  - g. Turn the Heading Set knob if necessary to select "1.CALIBRATE" then press the Heading set knob in to select the function.
  - h. Turn the knob to select "2. RIGHT STOP SOUTH" then press the Heading Set knob in to select. You may see the display change to 179 or 180 and the display will say RIGHT STOP.
10. If this is a new installation, rotate the system to the center of rotation. You are now ready to install the rotator system in your tower or on your mast. Refer to the instructions in your rotator manual for complete installation information.

## Operation of DCU-3 Controller

### Menu Functions

#### Menu Items

1. CALIBRATE
  - a. 1. LEFT STOP SOUTH
  - b. 2. RIGHT STOP SOUTH
2. OFFSET
  - a. Encoder sets the offset from the original setup. Dial in the amount and press the encoder to select the change
  - b. 0 to 360 degrees
3. CALLSIGN
  - a. Turn the encoder to display the character then press the encoder to select and advance to the next character. Press a second time to save the call sign.
4. DEFAULTS
  - a. Resets back to original settings. Select YES or NO to reset.
  - b. All memory settings are retained till it is set back to Default.
5. BRAKE DELAY
  - a. Default is 3 seconds
  - b. Turn the encoder for 0 to 8 seconds in 0.1 second steps.
6. NORTHSTOP
  - a. Default is NO
  - b. Use the encoder to select YES or NO then press the encoder.
7. SLEEP DELAY
  - a. Default is 10 minutes
  - b. Set 1 to 255 minutes or 0 for always on.
8. COAST SET
  - a. Default 0
  - b. Sets the heading that will turn off the motor before it reaches the heading so it will coast to that heading. 0 to 10 degrees. Use this in conjunction with the Brake Delay.
9. REVERSE LCD
  - a. Default is NORMAL where the characters are light and the background is blue/dark.
  - b. REVERSE is blue/dark characters and light background.

## Menu Details

**OFFSET** is used to compensate for any mechanical errors that may be in the antenna heading. For example: if the antenna is set to 360 degrees and it is found to be actually pointing at 355 degrees, the OFFSET can be set to compensate for this error.

**BRAKE DELAY** has a default of 3 seconds. For antennas that have a large mass adjust it to allow the antenna to quit moving before the brake engages.

**COAST SET** is used to compensate for overshoot of the heading. The inertia of large mass antennas will cause them to pass the desired heading and setting this adjustment will help by turning off the motor and let the antenna coast to the desired spot. This will have to be tried experimentally to find the best setting for your antenna. This in conjunction with the Brake Delay will set the required time to insure the antenna has stopped before locking down the desired heading.

**CALLSIGN** is used to set up the call sign display on the screen if desired. Select the menu function then enter the characters by turning the Heading Set knob to the desired character then press the knob in to allow selection of the next character. Once all the characters have been entered press the knob again to exit the mode.

**NORTHSTOP** In some cases you may want your antenna centered toward the south with the stops at the north. If this is the case put up the antenna pointed to the south, and once installed and ready, select this function and turn the Heading Set knob to select YES then press the knob in.

**SLEEP DELAY** is used to put the control into a sleep mode where the LCD back light turns off and the microprocessor goes into a low power state. It will wake back up with the press of any button or any command on the COM port. Selecting this menu will allow you to set the time from 0 to 240 in minutes. 0 is always on. When the unit goes to sleep the back light will turn off. Pushing any button, turning the Heading Set, or a computer command will wake it up.

**REVERSE LCD** changes the characters and background from dark blue background and white letters to a white background and dark letters as viewed from straight on. When viewed from a side angle or above the display at the display viewing limits, the characters in normal mode may look dark with a light background. To select the reverse mode select this menu item then turn the Heading Set knob to say YES for reverse or NO for normal then press the knob to select.

## Manual Operation

**MANUAL ROTATION** This mode is like the simpler controllers where pressing the LEFT or the RIGHT button will cause the rotator to move to the left/CCW or the right/CW. The brake will disengage and stay disengaged for the delay time after the release of the LEFT or RIGHT buttons.

**HEADING SET** This mode you can dial in the desired heading with the HEADING SET knob then pressing the ROTATE button. The antenna will rotate to the selected heading and then stop. The rotator will normally stop within about 2 degrees of the desired heading once the COAST SET is set correctly. Fine tuning of the heading can be made with the manual buttons if desired. Holding in the ROTATE button for more than 2 seconds will set the reverse heading.

**MEMORY STORAGE** To store headings in memory rotate the antenna to the desired heading then hold the PROGRAM MEMORY button M1 to M6 in till the display shows "PROG" above the Local Heading

## Computer Operation

The DCU-3 may be controlled from your computer via an RS-232 cable connection or a USB connection and can use either but not both at the same time. To select which one to use take the top cover off of the DCU-3 and on the back of the main board is a jumper on a 3 pin header. For RS-232 put the jumper between the center and the R side pin. For USB put the jumper between the center pin and the U side pin.

### RS-232

The rear panel has two (2) RS-232 connectors. The connector marked "INPUT" is a DB9 female connector and should be directly connected to the host computer. Do

not use a null-modem connection. The connector marked "OUTPUT" is a DB9 male connector and can be connected to other ham equipment such as a modem, TNC, or radio interface unit. The cable which is attached to the computer and to the DCU-3 should have a DB9 male connector at one end and either a DB9 female or DB25 female connector at the other end. The connections should be straight through, e.g. pin 1 to pin 1, pin 2 to pin 2, etc if both ends have 9 pin connectors. If a DB25 female connector is used to attach to the computer's COM1 or COM2 port, use the wiring guide shown in Figure 5. You may also purchase a pre - assembled cable from Hy-Gain to connect your computer to the DCU-3. Order either DCU-9P or DCU-35P cable assemblies.

### USB

For USB communications plug a USB cable with the proper connector to the DCU-3 and then the other end into the computer USB port. First time installation may require installation of drivers for the USB IC. Windows 7 should automatically find the drivers for you otherwise these can be found at the USB Chip manufacturer's web site: <http://www.ftdichip.com/Drivers/VCP.htm>. Choose the operating system and download the drivers. Follow the instructions that are included on the web page: <http://www.ftdichip.com/Support/Documents/InstallGuides.htm> for your operating system. Once the drivers are installed and the hardware is installed and ready to use you can then control the DCU-3 with any of the software available that will control the DCU-1. The DCU-1 DCU-2 and DCU-3 use the same command set. The USB chip is powered from the USB port so the port used must be able to supply power.

Signal Name	DB9 PIN	DB25 PIN
DCD Data Carrier Detect	1	8
RD Receive Data	2	3
TX Transmit Data	3	2
DTR Data Terminal Ready	4	20
GND Signal Gnd	5	7
DSR Data Set Ready	6	6
RTS Request To Send	7	4
CTS Clear To Send	8	5
RI Ring Indicator	9	22

Figure 5 RS-232 Wiring Guide

## Software Control

Follow the instructions for the software package that you use to control the rotator for setup and operation. For example in Ham Radio Deluxe the Rotator control module asks for the Controller Type and the COM Port number. Other software vendors may also include the ability to directly control the DCU-3 from within a logging or rig control program. Use the DCU-1 (or DCU-3 if in the list) and look for the COM port that the DCU-3 is plugged into. For RS-232 you should have a list of COM 1-4 (or more)

depending on what is installed in the computer and you would choose the one that the DCU-3 is plugged into. For USB you should have the COM 1-4 list and then a higher number COM list of the devices plugged into the computer that act as virtual com ports. Choose the one that the DCU-3 is connected to. If you unplug the DCU-3 the USB com port should no longer be available. If you have chosen the correct com port then when instructed by the software the rotator should respond to the commands. If not then try one of the other com ports.

## COMMAND SET

There are 2 commands the DCU-3 is looking for that are sent as ASCII characters.

Command:	Result:
AP1***;	Sets Target Bearing in DCU-3 (** is a three digit number between 000 and 359)
AM1;	Starts Rotation to Target Bearing

**Figure 6 Command Set**

The COM port should be used at 4800 baud with no parity, 8 data bits, 1 stop bit and ASCII mode. This is usually shown as "4800,N,8,1".

After a command is sent to the DCU-3, all other motor and brake operation is

automatic. There are no provisions at this time to send current bearing information back to the computer.

You may wish to check with our Customer Service Dept. from time to time in order to obtain the latest firmware upgrades.

## Troubleshooting

### CAUTION:

This unit has been thoroughly tested and cycled before shipment. Follow the connector wiring carefully between the rotator and the DCU-3 control box. Pin #1 must attach to Pin #1, etc... Incorrect

wiring will burn out the rotator potentiometer and void the warranty.

The DCU-3 control unit is designed to be used ONLY with Hy-Gain HAM-IV (type) and T2X rotator systems. Do not try to use this control on other systems.

### Wiring

Most operational difficulties with rotators are traceable to broken, shorted, grounded or miswired control cables. Time spent on assembling, routing and protecting the control cable will lead to a long trouble-free rotator life.

Unintentional grounds on cable leads can burn out the line fuse in the DCU-3 control box or burn out the potentiometer in the rotator. If pin #3 is grounded, the heading will be wrong and possibly not rotate in the proper direction. Note also that any grounds may put an overload on the power transformer which could cause the line fuse to blow.

### Antenna Motion

A slight amount of "play" is built into the rotator to avoid binding due to environmental changes.

If the antenna actually rotates in high winds, this is usually just the mast slipping in the rotator or the antenna slipping on the mast. For large antennas, it is often necessary to drill a 5/16" hole through the rotator clamping plate and mast and pin them together with the bolt provided. Also, if possible, pin the antenna to the mast with appropriate hardware. If slipping is suspected, return the rotator to an end of

rotation limit and visually check antenna alignment.

### Lack of Power

If the antenna rotation is slow or sluggish or hard to start, check for proper voltages on pins #2,5, and 6. (See Table 4) If the voltages are correct, the 130 - 156 MFD capacitor may be old. If your unit is more than 5 years old, try replacing this capacitor. Also, if your cable run is over 200 feet, make sure that you are using the proper wire size. See Table 2. For cable runs over 300 feet, you may wish to move the motor capacitor to the tower. This allows you to run only 6 wires from the control to the rotator, so that you can reduce wire resistance by doubling up wires or using fewer, heavier wires.

If the electrical circuit is working, then check for mechanical problems. Look for mast binding or thrust bearing misalignment if you have experienced strong winds recently. If the temperature is less than -30 deg. F (-34 deg. C), the rotator will be very sluggish or may not run at all! This is normal. Do not try to rotate with the DCU-3 control if temperatures are below -30 deg. F! Older models of HAM-M, 11, 111, IV and T2X rotators may be very sluggish at temperatures less than 0 degrees F.

Problem	Possible Cause
Antenna Bearing doesn't match display	Mast slipped in rotator clamp
	Antenna slipped on mast
	DCU-3 Calibration not performed
Current Bearing changes randomly or does not change at all	Potentiometer broken or burned-up
	Shorts or opens in control cable
	Extremely high RF field near rotator
	DCU-3 MPU or A/D failure
	Tower or DCU-3 not grounded
Antenna Bearing changes by itself	Brake wedge failure
	DCU-3 MPU failure
Current Bearing changes +/- less than 3 degrees	Antenna rocking in high winds
	Potentiometer dirty or poor connection
	High RF field near rotator
	Long (200') control cable
Rotator unable to reach target bearing	Temperature less than -30 degrees F
	Broken teeth in gears
	Shorts or opens in control cable
	Thermal cut-out in power transformer
	Mast binding in tower
	Old motor-start capacitor
	High winds, high wind area
	Control cable wire size too small
	DCU-3 MPU failure
	Temperature between -30 and 0 degrees F
Rotator slow to reach target bearing	Broken teeth in gears
	Mast binding in tower
	Old motor-start capacitor
	High winds, high wind area

Table 4 Trouble Shooting Suggestions

### Checking the Control Unit Voltages

To check the control unit voltages, first remove the rotator control cable from the DCU-3 control box, then plug the line cord into a 120 VAC outlet. Set the target bearing

at least 10 degrees from the current bearing. Press "ROTATE" to check the voltages on pins 2, 5, and 6. Check for the following voltages on the 8 pin connector:

Pin #'s	Ambient State	Press "ROTATE" (see note)
1-2	0	30 VAC
1-5	0	30 VA C (for CW rotation to target)
1-6	0	30 VA C (for CCW rotation to target)
4-8	0	0
3-1	+ 8.0 to 9.0 VDC	+ 8.0 to +9.0 VDC (with Rotator Cable disconnected)
	0 to 4.5VDC	0 to 4.5VDC With Rotator Cable connected, depending on Rotator Position

Table 5 Voltage Readings

#### NOTE:

**You have 8 seconds after pressing "ROTATE" to make each measurement. The DCU-3 checks for movement, and after 8 seconds without movement, it**

**stops trying to rotate. You may wish to make your meter connections with alligator clips, then press "ROTATE" when you are ready to read the meter.**

### Checking the Rotator Resistances

You may possibly avoid bringing the rotator down from the tower by making electrical resistance checks on the control cable. Disconnect the control cable from the control box. Check for the following resistances.

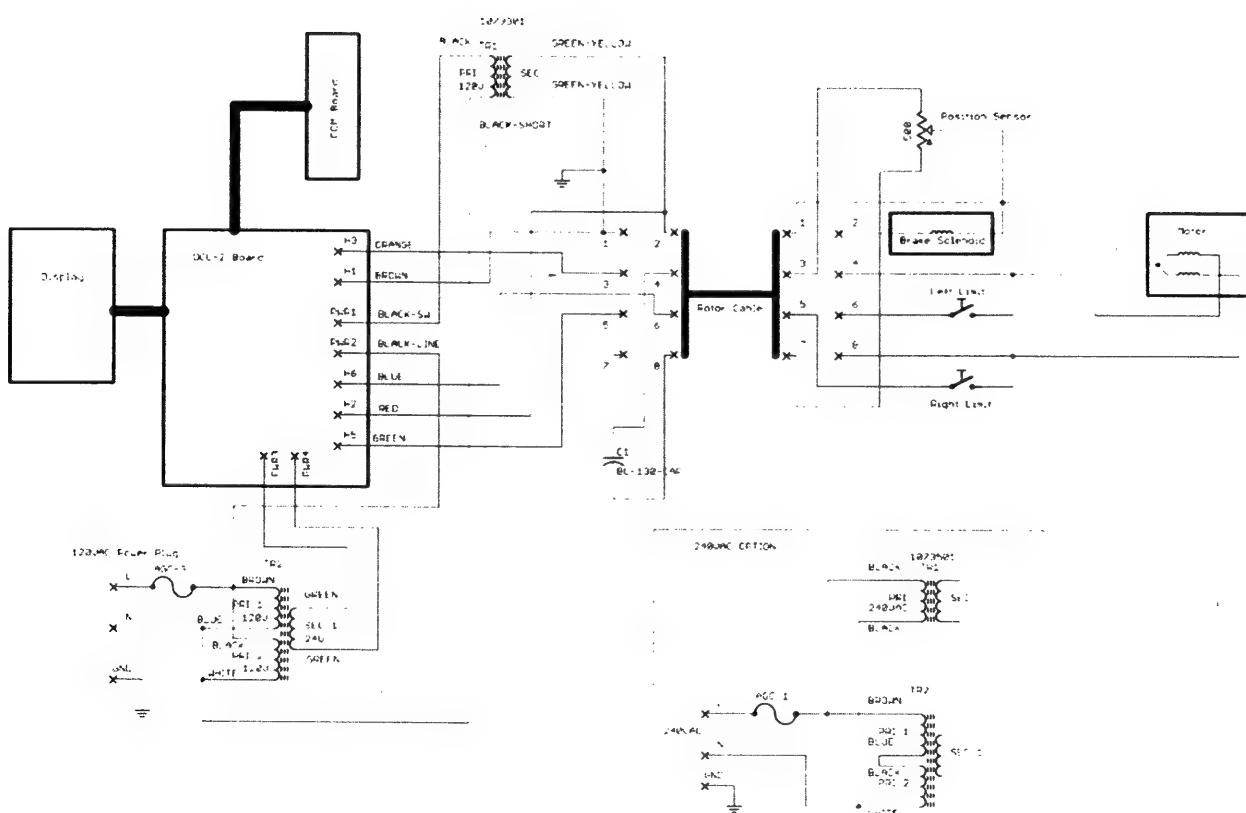
Description	Pin #'s	Approximate Resistance (ohms)
Brake Solenoid	1-2	0.75 + cable resistance
1/2 Motor Winding	1-8	2.5 +cable resistance
1/2 Motor Winding	1-4	2.5 +cable resistance
1/2 Motor Winding + switch	1-6	2.5 +cable resistance
Entire Motor	4-8	4.5 + cable resistance
Right Limit Switch	5-8	0 +cable resistance
Left Limit Switch	4-6	0 + cable resistance
Entire Pot	3-7	500 + cable resistance
Pot Arm to + End	1-3	0 to 500 ( 0 at full CCW)
Pot Arm to - End	1-7	0 to 500 ( 500 at full CCW)

**Table 6 Rotator Resistance Readings**

## Heading Notes

Reading and control near the stops may not always go to the exact location instructed. Normally the antenna will stop within 5 degrees of the programmed heading. Near the right stop the measured voltage is very

low and noise and high AC hum interfere with the readings. Headings between 180 and 200 degrees and between 180 and 160 degrees off of the right stop may be difficult to reach with automatic control.



**Figure 7 DCU-3 Block Diagram**

### DCU-3 Digital Antenna Rotator Controller

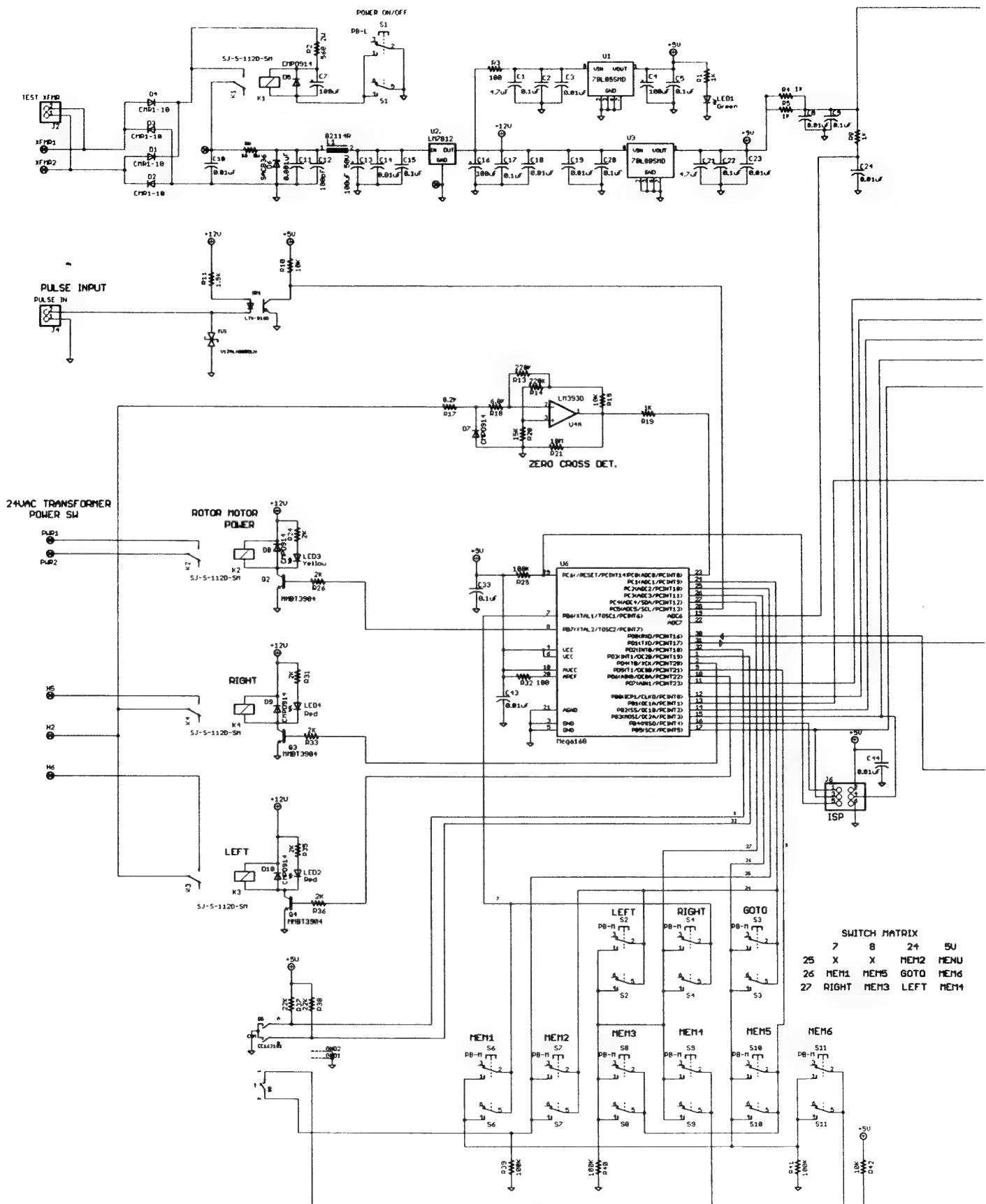
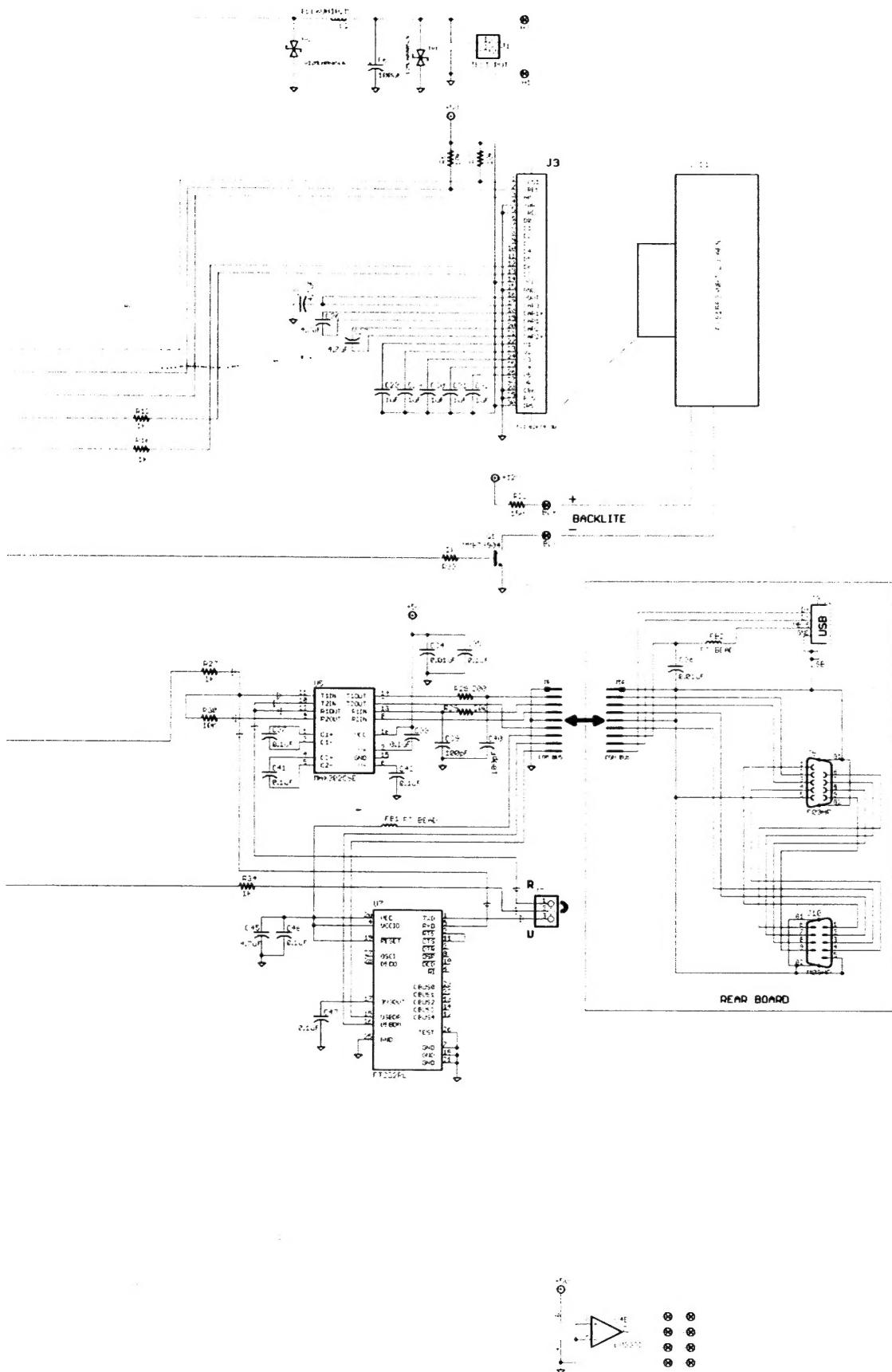


Figure 8 L DCU-3 Main PCB Schematic

*DCU-3 Digital Antenna Rotator Controller*



**Figure 9 R DCU-3 Main PCB Schematic**

**Table 7 Chassis Parts**

Part Num	Value	Quantity
500160	10-24X5/8 SS Screw	1
520057	6-32X3/8 Black type F	8
551153	10-24 wing nut SS	1
554071	10-24 SS NUT	1
556990	8-32 SS NUT	4
640076	8 pin Female Jones Connector	1
667621	#10 ring lug crimp on	3
671673	Spade lug crimp on	2
1073301	MAIN transformer 120V (for 120VAC units only)	1
1073501	MAIN transformer 240V (optional for 240VAC units only)	1
5017702	Meter Transformer	1
5104700	#8 EXT TOOTH Lock Washer	4
270-6220-1	220uF 25V capacitor	1
610-5020	Power Connector	1
654-0187	4-40X3/16 screw	8
654-0250	4-40X1/4 screw	4
654-0500-CP	4-40X1/2 SS Flat Head Screw	2
654-0500S	4-40X1/2 SS screw	4
656-0250S	6-32X1/4 SS screws	7
705-0440S-K	4-40 KEP NUT	9
705-0632S-K	6-32 KEP Nut	7
711-1037-EX	#10 EXT TOOTH Lock Washer	2
716B-0250	4-40 X 1/4 hex threaded spacers	4
716B-0250	4-40X1/4 hex threaded spacers	4
716B-0500	4-40 X 1/2 hex threaded spacers	4
5151501	130 uF Motor Run Capacitor	1
745-2149	white tie wraps	2
745-2158B	black tie wraps	2
755-2148	Fuse Holder	1
760-0033	Knob	1
770-6014	Grommet	2
782-DCU3	Front Panel Decal	1
800-DCU2	Chassis	1
802-DCU3	Front Panel	1
803-DCU2	Back Panel	1
5086100	Power Cord (120VAC)	1
5079800	Power Cord (optional 240VAC)	1
755-0103	3A 250V Fast Blow AGC-3 (120VAC)	1
755-0101	1A 250V Fast Blow AGC-1 (optional 240VAC)	1
810-8800	Top Cover	1
810-8801	Bottom Cover	1

**Table 8 Printed Circuit Board Parts**

Part Num	Value	Parts	Qty
200S-4470-1	4.7uF	C1, C21, C25, C26, C27, C45	6
200S-1100	0.001uF	C11	1
200S-0100	100pF	C12, C39, C40	3
270S-6100-2	100uF 50V	C13	1
200S-3100	0.1uF	C2, C5, C9, C15, C17, C20, C22, C33, C35, C37, C38, C41, C42, C46, C47	15
200S-4100	1uF	C28, C29, C30, C31, C32	5
200S-2100	0.01uF	C3, C8, C10, C14, C18, C19, C23, C24, C36, C43, C44	11
200S-3100	0.01uF	C34	1
270S-6100	100uF	C4, C6, C7, C16	4
300S-4007	CMR1-10	D1, D2, D3, D4	4
300S-0914	CMPD914	D5, D7, D8, D9, D10	5
301S-0036	SACB36	D6	1
401S-5100	FT BEAD	FB1, FB2	2
612-0102	TEST POT pin header	J1	1
610-3109	M09HP DB-25	J10	1
612-0102	TEST XFMR pin header	J2	1
612S-5030	FCI-62674-30	J3	1
612-0225	ISP pin header	J6	1
612-0103	R/U Selector pin header	J7	1
610-3009	F09HP DB-25	J8	1
601-8201	USB-B Jack	J9	1
408-1214	SJ-S-112D-SM	K1, K2, K3, K4	4
412-6131-PW	82114R	L1	1
401S-6100-2	ELL6UH102M	L2	1
351-5005	Green	LED1	1
351-5002	Red	LED2, LED4	2
351-5004	Yellow	LED3	1
356-0816-SM	LTV-816S	OP1	1
305-3904-SM	MMBT3904	Q1, Q2, Q3, Q4	4
100S-3100	1K	R1, R4, R5, R8, R12, R16, R19, R27, R34	9
100S-3150	1.5K	R11	1
100S-5220	220K	R13, R14	2
100S-3820	8.2K	R17	1
100S-3680	6.8K	R18	1
104-2560	560 2W	R2	1
100S-4150	15K	R20	1
100S-7100	10M	R21	1

100S-2150	150	R22	1
100S-3200	2K	R23, R26, R35, R36	4
100S-3200	2K	R24, R31, R33	3
100S-5100	100K	R25, R39, R40, R41	4
100S-2200	200	R28, R29	2
100S-2200	100	R3, R32	2
100S-4220	22K	R37, R38	2
100S-4100	10K	R6, R7, R10, R15, R30, R42	6
105-1510W	50 ohm 5W	R9	1
504-2022	PB-L	S1	1
504-2022M	PB-M	S2, S3, S4, S6, S7, S8, S9, S10, S11	9
580-0023	EC162101	S5	1
304S-12250	V12MLA0805LN	TV1, TV2, TV3	3
307S-78L05	78L05SMD	U1	1
307-7812	LM7812	U2	1
307S-78L08	78L08SMD	U3	1
324-0393-SM	LM393D	U4	1
325-0202-SM	MAX202CSE	U5	1
328-0168-SM	Mega168	U6	1
325-0232RL-SM	FT232RL	U7	1
354-51320	F-51320GNBJ-LW-AEN	LCD1	1
862-DCU3	PC Board		1
760-2059	White PB cap		8
760-2052	Red PB Cap		2
750-0220	TO220 Heatsink		
654-0250	4-40X1/4 Screw		1
705-0440	4-40 nut		1